

General Notes

Age and Sexual Morphological Variation in the Kirtland's Warbler (*Dendroica kirtlandii*)

Although the Kirtland's Warbler (*Dendroica kirtlandii*) is one of the most extensively managed passerines in the world, virtually nothing has been published on its morphometrics. Mayfield (The Kirtland's Warbler, Cranbrook Institute of Science, Bloomfield Hills, Michigan, 1960) looked at sexual variation in weight ($n = 64 \sigma^{\circ}$ and $13 \text{ } \text{?}$) and Ridgway (Bull. U.S. Natl. Mus. No. 50, part II, 1902) tabulated wing, tail, exposed culmen and tarsus measurements ($n = 5 \sigma^{\circ}$ and $7 \text{ } \text{?}$). The purpose of this study of the Kirtland's Warbler was to quantify the morphological variation within and among sex classes and adult age classes (breeding yearlings vs. older adults): Of the 190 complete Kirtland's Warbler skins housed in the University of Michigan Museum of Zoology (UMMZ), 144 taken between 1 May-30 August were used. The excluded 46 specimens were nestlings, young in natal plumage, or birds taken during the fall-winter.

METHODS

The following characters were measured and recorded for each specimen: Sex. — From the data tag accompanying each specimen. Length of flattened wing. — Measured from the bend of the flattened wing at the wrist to the distal tip of the longest primary. Length of tail. — Measured from the insertion of the central rectrices to their distal tip. Length of exposed culmen. — Measured from the anteriormost feathers on the forehead to the tip of the maxilla. Length of bill from anterior edge of nostril. — Measured from the anterior edge of nostril to the tip of the maxilla. Length of tarsus. — Measured from the junction of the tibiotarsal-tarsometatarsal joint to the distal edge of the distalmost undivided scute overlying the toes on the anterior side. (Little variation was found in the scutellation pattern of the feet.) Weight. — Taken directly from the specimen tag when present. When the bill or tarsus was broken, the plumage worn, or the bird in molt so as to render any plumage measurement inaccurate, it was not entered into the data set. Dial calipers were used to measure the bill and tarsus to the nearest 0.1 mm, and a ruler for the wing and tail to the nearest 1.0 mm.

According to Van Tyne (p. 421 in Bent, Bull. U.S. Natl. Mus. No. 203, 1953) first-year males can be distinguished from older males by the presence of a fine spotting pattern across the breast. First-year females cannot be separated from older females by breast spot patterning (Mayfield 1960). For males, juveniles were defined as birds that have only undergone postnatal molt; first-year as those in their first nuptial plumage; and adults as those in at least their second nuptial plumage. It should be noted that first-year birds are actually adults, in that the skull is ossified and they are capable of breeding. To test for measurement differences between males with different breast patterns, non-juvenile specimens were scored as either having or lacking a breast spot pattern. First-year males (i.e. possessing spotted breasts) were further subdivided into two groups, those with few or widely scattered spots ($n = 23$) and those with a more pronounced or heavily patterned breast ($n = 13$). These subsets were standardized by comparing each spotted specimen to UMMZ 113,903 (male taken 16 June 1945) and coding it as having fewer or an equivalent spotting pattern ("scattered spots") or a more distinct pattern ("heavy spots"). Non-juvenile females with

spotted breasts were treated as adults rather than first-year birds, although the degree of breast spotting was scored in a similar manner as in spotted males, using UMMZ 112,823 (female taken 28 June 1944) as the standard. Differences were tested among means and variances by Student's *t*-test or analysis of variance (ANOVA), as appropriate. When the ANOVA showed significant variation a Scheffé test was used to detect which means were significantly different. Tests used MIDAS programs, developed by the University of Michigan Statistical Research Laboratory. Probabilities of 0.05 or less are considered statistically significant and sufficient to reject the null hypothesis.

RESULTS

Age variation — The measurements for the six variables are summarized for the age and sex classes in Table 1. No significant differences were found between older males without breast spots and first-year males with breasts spots except for the wing, which was longer in the older males ($P = 0.005$). The 36 first-year males possessing a breast spot pattern were further subdivided into two groups, using the standards noted above. When males were separated into three groups, adults without spots and first-year birds with scattered and heavy spots, for the ANOVA, significant differences were found only in wing measurements ($P = 0.001$). When the wing measurements of these three groups were compared pairwise in a Scheffé multiple comparison, adult males and first-year males with few spots were not significantly different ($P = 0.16$), unspotted adult males had longer wings than heavily spotted first-year males ($P = 0.0004$), and first-year males with few spots had longer wings than those with heavy spots ($P = 0.02$). These results suggest that males without breast spots have the longest wings and that those with heavily spotted breasts have the shortest. Since no differences were found between males without breast spots and those with few spots, the original age criterion could be incorrect and both of these groups may belong to the same age class. In females no significant differences were found for any of the variables when compared among adults, juveniles, or breast spot classes.

Sexual dimorphism — Measurements for the six variables for males and females are presented in Table 1. Three separate *t*-tests comparing males and females with no spots, scattered spots and heavy spots showed that in all cases males had longer wings ($P = 0.00001$, $P = 0.00003$, $P = 0.00001$, respectively). Further, the heavily spotted males had longer tails than heavily spotted females ($P = 0.0006$). When adult males and first-year birds with few spots were pooled for both sexes, the males had longer wings ($P = 0.00001$) and tails ($P = 0.01$), while the females were heavier ($P = 0.01$, see discussion below). With adult, first-year and juvenile age classes combined, males had longer wings ($P = 0.00001$) and tails ($P = 0.00001$), but females were heavier ($P = 0.02$). The wing- and tail-lengths of juvenile males were significantly greater than those of juvenile females ($P = 0.0005$, $P = 0.002$, respectively).

DISCUSSION

The finding that non-juvenile females were heavier than non-juvenile males is clearly an artifact of pre-egg-laying weight gain. Mayfield (1960) reported that 75% of all nests had completed clutches between 30 May-13 June. Of the 11 adult females for which weights were available, four were collected in the egg-laying period and are the only specimens (male or female) weighing over 15 gms. When the weights of males and females taken after 15 June were compared, no significant differences were found. The greater weight variance among females is further evidence that they were in a wider range of physiological states.

The known breeding grounds of this species are confined to the northern portion of Michigan's lower peninsula. The number of Kirtland's Warblers on the nesting grounds

TABLE 1. Variation of Six Characters by Age and Sex from Kirtland's Warbler. Specimens Taken During the Period 1 May-30 August.¹

MEASUREMENT	MALE			FEMALE	
	ADULT NO SPOTS	FIRST-YEAR WITH SPOTS	JUVENILE	ADULT	JUVENILE
Wing					
N	53	36	5	33	11
Mean	71.7	70.8	71.2	68.0	68.2
SD	1.41	1.43	2.16	1.79	1.47
Range	69-75	68-75	69-74	64-71	67-70
Tail					
N	52	36	5	34	11
Mean	57.6	57.1	57.2	54.8	54.6
SD	2.17	1.62	1.09	1.99	1.36
Range	53-67	53-60	56-58	51-59	53-57
Exposed Culmen					
N	50	34	5	36	11
Mean	10.4	10.5	10.4	10.4	10.0
SD	.35	.55	.21	.56	.57
Range	9.4-11.1	9.5-12.2	10.1-10.7	9.5-11.7	9.0-11.0
Bill from Nostril					
N	50	35	5	37	11
Mean	8.1	8.1	8.1	8.1	7.8
SD	.26	.32	.29	.30	.38
Range	7.5-8.7	7.5-8.8	7.7-8.5	7.5-8.6	6.9-8.4
Tarsus					
N	52	36	5	37	11
Mean	21.2	21.4	21.5	21.2	21.0
SD	.61	.71	1.03	.58	.54
Range	19.5-22.9	19.9-22.7	20.3-22.5	19.8-22.3	20.2-21.8
Weight					
N	31	21	0	11	1
Mean	13.6	13.8	—	14.3	—
SD	.59	.53	—	1.18	—
Range	12.3-14.6	12.5-14.7	—	12.4-16.0	13.6

¹N = number. SD = standard deviation.

has been estimated during 13 breeding seasons (between 1951-1981) by counting the number of singing males on territory. Since this species is rarely polygynous (Mayfield 1960) and no evidence has been presented for unequal sex-ratios, it is presumed the total number of singing males represents approximately half of the breeding population (see Mayfield 1960 for details on census techniques). Censuses conducted on the Michigan breeding grounds have yielded the following results: 432 males in 1951, 502 males in 1961, 201 males in 1971, and 167-242 males during 10 censuses between 1972-1981 (summarized in Ryel, Jack-Pine Warbler 50:93-95, 1981). Of the 144 Kirtland's Warbler

specimens used in this study the most recent was taken in 1956, 128 (89%) were collected before 1950, and 92 (64%) were secured before 1935, all well before the distinct drop in singing males was noted. Most of the birds were collected by researchers working on the breeding biology of the bird, and only a few were taken in most years. The drastic decline in numbers occurred at least 10 years after the vast majority of the specimens in UMMZ were collected and there is no evidence that the two are related.

The use of breast spots as an aging character still needs verification. This would be best accomplished by following the plumage sequence of birds banded as nestlings through time.

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The Kirtland's Warbler In 1982

Kirtland's Warbler (*Dendroica kirtlandii*) was first described and named by Spencer F. Baird in 1851 (Mayfield, The Kirtland's Warbler, Cranbrook Inst. Sci., Bull. 40, Bloomfield Hills, MI, 1960). One-hundred years later, Harold Mayfield organized the first census of the species — a project generally recognized as the first such undertaking for any songbird (Mayfield, Auk 70:17-20, 1953). Since that time, 13 more censuses were carried out, the next 2 at ten-year intervals (Mayfield, Auk 79:173-182, 1962; Auk 89:263-268, 1972), and annually since 1971 (Mayfield, Auk 90:684-685, 1973; American Birds 27:950-952, 1973; Jack-Pine Warbler 53:39-47, 1975; Ryel, Jack-Pine Warbler 54:2-6, 1976; Michigan Dept. Nat. Res. S.S.S. Rept. No. 152, 1976; Jack-Pine Warbler 57:141-147, 1979; Jack-Pine Warbler 58:30-32, 1980; Jack-Pine Warbler 58:142-145, 1980; Jack-Pine Warbler 59:93-95, 1981; Burgoyne and Ryel, Jack-Pine Warbler 58:185-190, 1978). Mayfield coordinated the censuses through 1975. Thereafter the Kirtland's Warbler Recovery Team delegated the job to the Surveys and Statistics Section of the Wildlife Division, Department of Natural Resources (DNR). The 1982 survey was the seventh organized by this unit. Overall management of the species is directed by the Recovery Team, and census results are used to monitor population trends as well as evaluate management practices.